

REMARKS/ARGUMENTS

Favorable reconsideration of this application, in light of the present amendments and following discussion, is respectfully requested.

Claims 1-11 and 13-19 are pending. The specification and Claims 1, 6, 13, and 18 are amended. Support for the amendments to Claims 1, 6, 13, and 18 can be found in the specification on page 2, lines 13-20 and page 25, lines 8-12, for example. No new matter is added. Claim 12 was canceled previously.

In the outstanding Office Action, the specification was objected to for informalities. Claims 1-5 and 13-19 were rejected under 35 U.S.C. § 102(b) as anticipated by Van Autryve et al. (U.S. Patent No. 6,014,979, herein "Van Autryve"). Claims 13-19 were rejected under 35 U.S.C. § 102(b) as anticipated by Qian et al. (U.S. Patent No. 6,136,211, herein "Qian"). Claims 1-5 were rejected under 35 U.S.C. § 102(e) as anticipated by Chen et al. (U.S. Patent N. 6,394,104, herein "Chen"). Claims 6-11 were rejected under 35 U.S.C. § 103(a) as obvious over Van Autryve in view of Qian.

Regarding the objection to the specification for informalities, page 29 of the specification is amended to address the typographical error. Support for the amendment to the specification can be found on page 6, lines 7-9, for example. Accordingly, Applicant respectfully submits that the objection to the specification is overcome.

Regarding the rejection of Claims 1-5 as anticipated by Van Autryve, that rejection is respectfully traversed by the present response. Additionally, the rejection of Claims 1-5 as anticipated by Chen is respectfully traversed by the present response.

By way of review, the invention recited in amended independent Claim 1 is directed to a plasma processing method. In the claimed plasma processing, sequential steps of first plasma processing, dry cleaning, and second plasma processing are carried out in a single chamber. In particular, a first and a second CF-based gas are used in the first and the second

plasma process, respectively, and an F/C ratio of the first CF-based gas is smaller than that of the second CF-based gas. In other words, **the second plasma process uses a gas whose F/C (fluorine/chlorine) ratio is larger than an F/C ratio of the CF-based gas used in the first plasma processing.** Further, the dry cleaning step is performed by supplying into the chamber **a deposit removing gas and a dummy substrate etching gas.**

Still further, the dry cleaning step is performed by supplying a deposit removing gas and a dummy substrate etching gas into the chamber **to stabilize an etching rate of the second plasma processing step carried out right after the dry cleaning step.**

Conventionally, due to the unstable etching rate and in-surface uniformity right after the dry cleaning step, **a seasoning process is needed right after the dry cleaning process.**

However, in accordance with the present invention, **a seasoning process right after the dry cleaning process can be avoided.** As a result, additional effort and time required for the seasoning process can be saved and the operating rate of a series of plasma processes can be enhanced.

In contrast, in Van Autryve, the same processing step using a same gas is repeated after the cleaning step. See Claim 1 of Van Autryve, which states:

A method of processing a substrate in a process chamber, the method comprising the steps of:

(a) in a processing stage, placing the substrate in the process chamber, maintaining a surface of sacrificial material around the substrate, introducing process gas into the process chamber, and energizing the process gas whereby the surface of sacrificial material adds or removes species from the process gas to change a processing rate at the substrate periphery; and

(b) in a cleaning stage, removing the substrate, introducing a cleaning gas into the process chamber, and forming a localized cleaning plasma sheath from the cleaning gas that is localized to the surface of the sacrificial material to remove process residue formed on the surface of the sacrificial material substantially without extending to and eroding sidewalls of the process chamber.

Accordingly, after the cleaning stage, the substrate is removed. The substrate is then placed in the process chamber, and the processing gas is not disclosed as different from the original process gas.

Chen describes that the step of etching a spin-on-glass layer is repeated after removing a polymer. See claim 1 of Chen, which states:

A method of removing polymer buildup from the surfaces of an etching chamber comprising:
providing said etching chamber in which spin-on-glass etchback is performed whereby said polymer buildup is formed on said surfaces of said chamber including an upper electrode in said chamber;
placing a dummy wafer into said etching chamber; and
removing said polymer buildup from said surfaces of said chamber including said upper electrode using a dry plasma cleaning process comprising flowing Ar at 300 to 500 sccm, flowing O₂ at 15 to 100 sccm, and flowing CF₄ at 40 to 100 sccm under a pressure of 200 to 600 mTorr and power of 500 to 1000 watts for a duration of 20 to 50 minutes.

In other words, the same gas is used for the first and the second processing step of Van Autryve and Chen.

Moreover, Van Autryve and Chen are each silent regarding the recited features “to stabilize an etching rate of the second plasma processing step carried out right after the dry cleaning step.”

One benefit of the above-noted differences between the invention recited in Claim 1 and the disclosures of Van Autryve and Chen is that the invention recited in Claim 1 helps avoid the effort and time required for the seasoning process, and the operating rate of a series of plasma processes can be enhanced.

Thus, Van Autryve and Chen do not disclose the above-noted features of the invention recited in amended independent Claim 1. Accordingly, it is respectfully submitted that the amended Claim 1 patentably distinguishes over Van Autryve and Chen, taken alone or in any proper combination.

Regarding the rejection of Claims 13-19 as anticipated by Qian, the rejection of Claims 13-19 as anticipated by Van Autryve, and the rejection of Claims 6-11 as obvious over Van Autryve and Qian, those rejections are respectfully traversed by the present response.

Amended independent Claim 6, in addition to the new features recited in Claim 1, recites that a ratio of a flow rate of the dummy substrate **etching gas** to that of the **deposit removing gas** (cleaning gas) is not less than about 0.14% but not larger than about 7.1%. The outstanding Office Action acknowledges that Van Autryve is silent regarding the recited ratio and relies on Qian for the above-noted feature.¹

However, Qian describes only that a flow ratio of the **cleaning gas (CF₄)** to the **etchant gas (Oxygen)** is 1:20. In other words, the amount of etchant gas in Qian is much larger than the amount of cleaning gas. The section of Qian cited in the outstanding Office Action for the above-noted feature states:

The volumetric flow **ratio of cleaning gas to etchant gas** is selected to remove the etchant residue generated from processing at least 2000 substrates 25, and more preferably at least 3000 substrates, without performing a separate cleaning step for cleaning the chamber 30 in between processing of the substrates. A suitable volumetric flow ratio of cleaning gas to etchant gas is from about 1:20 to about 1:1, and more preferably from about 1:10 to about 2:3, and most preferably about 2:3. It has been discovered that at these volumetric flow ratios of cleaning gas to etchant gas, substantially all the etchant residues on the chamber surfaces 45, 50, 55 are removed without eroding the chamber surfaces.²

In other words, Qian discloses a flow ratio of 2000%, which is much more than the flow ratio range recited in Claim 6. Accordingly, Claim 6 patentably distinguishes over any proper combination of Van Autryve and Qian.

¹ Outstanding Office Action, page 7.

² Qian, col. 9, lines 20-32.

Amended independent Claims 13 and 18 recite the above-noted features of Claims 1 and 6, respectively, and patentably distinguish over Van Autryve and Qian, taken alone or in any proper combination, for at least the reasons discussed above.

Further, the apparatuses recited in Claims 13 and 18 are configured to perform the sequential steps of first plasma processing, dry cleaning and second plasma processing **in a same chamber**. In other words, the apparatuses recited in Claims 13 and 18 are configured to perform **three different plasma processes in a same chamber**.

In contrast, Qian describes an apparatus configured to perform steps of first etching and second etching wherein a processing gas of the first etching step is a mixture of an etchant gas and the cleaning gas.

Further, in Van Autryve, the same processing step using a same gas is repeated after the cleaning step. That is, the apparatuses of Qian and Van Autryve are configured to carry out only **two** different steps in the same chamber.

Accordingly, Claims 13 and 18 patentably distinguish over each Van Autryve and Qian and any reasonable combination thereof for at least the reasons discussed above.

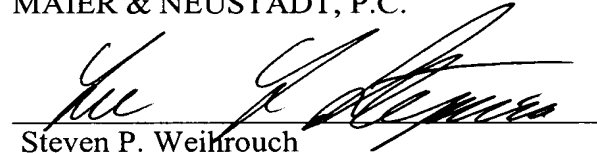
It is also respectfully submitted that Claims 2-5, 7-12, 14-17 and 19, directly depending from one of Claims 1, 6, 13 or 18 are allowable for the same reasons indicated with respect to amended independent Claims 1, 6, 13 or 18, and further because of the additional features recited therein which, when taken alone and/or in combination with the features recited in Claim 1, 6, 13 or 18, further patentably distinguish over any proper combination of the cited references.

For the foregoing reasons, it is respectfully submitted that this application is now in condition for allowance. A Notice of Allowance for Claims 1-11 and 13-19 is earnestly solicited.

Should Examiner Carrillo deem that any further action is necessary to place this application in even better form for allowance, Examiner Carrillo is encouraged to contact Applicant's undersigned representative at the below-listed telephone number.

Respectfully submitted,

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